PATENT APPLICATION
Docket No.: 47769-00009
RL.P50940US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of: Björn EHRSTEDT et al.

For: PACKET TRANSMISSION IN A UMTS NETWORK

BOX PATENT APPLICATION
Commissioner of Patents
Washington, D.C. 20231

Sir:

PATENT APPLICATION TRANSMITTAL LETTER

Transmitted herewith for filing, please find the following:

1. (XX)   The specification of the above-referenced patent application is
            enclosed herewith (_11_ page(s) including claim(s) and Abstract).

2. (XX)   _3_ sheet(s) of:
            ___ informal drawing(s) is (are) enclosed herewith.
            _X_ formal drawing(s) is (are) enclosed herewith.

3. (X) The fees for this application have been calculated and included as shown below (Prior to calculating the fees, please enter any enclosed preliminary amendment.):

	NO. FILED	NO. EXTRA	RATE	FEE
BASIC FEE				$710
TOTAL CLAIMS	8-20	0	S18	0
INDEPENDEN T CLAIMS	2- 3	0	$80	0
MULTIPLE DEPENDENT CLAIM(S) PRESENTED			$270	
TOTAL FEES:				$710.00
Deduct One-Half for Small Entity Status				
Assignment Recordal Fee			S40	
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4. __X__ Check in the amount of $ _710_ is enclosed herewith. Please charge any deficiency or credit any overpayment to Deposit Account No. _10-0447_.

___ Please charge my Deposit Account No. _____ in the amount of $_____. Please charge any deficiency or credit any overpayment to Deposit Account No. _____.

5. (X) An oath or declaration is enclosed herewith that is:
__X__ Unsigned
___ Newly executed per 37 CFR 1.63(a) and (b).
___ A copy of the executed declaration filed in the prior application upon which priority is based, showing the signature or an indication thereon that it was signed; and:
___ This application is being filed fewer than all of the inventors named in the prior application and it is requested that the following name or names be deleted from the list of inventors in the prior application for this continuation or divisional application:
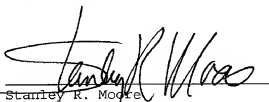
_____

___ The prior application was accorded status under 37 CFR § 1.47 and is accompanied by:

      ____   A copy of the decision granting a petition to accord Sec. 1.47 status to the prior application (unless all of the inventors have or legal representatives have filed an oath or declaration to join in the prior application).

      ____   A copy of the subsequently executed oath(s) or declaration(s) filed by the inventor(s) or legal representative(s) that have subsequently joined in the prior application.

6. (X)   The power of attorney for this application:

      ____   is appointed in the newly executed Oath or Declaration submitted herewith.

      _X_   is appointed by the power of attorney enclosed herewith.

      ____   remains the same as originally in the parent application.

      ____   was changed during the prosecution of the parent application and a copy of the change in the power of attorney is enclosed herewith.

7. (XX)   The correspondence address for this application shall be:

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      _X_   which is a new correspondence address or a change therein.

      ____   which is the same as originally in the parent application.

      ____   which is the change in the correspondence address that was filed during the prosecution of the parent application.

8. (X)   Priority is hereby claimed under 35 USC 119 and 172 to the following foreign applications:

Country	Serial No.	Date
Great Britain	GB9924764.5	19 Oct 1999

and:

      _X_   A certified copy of each application is enclosed herewith.

      ____   A certified copy of each application was filed in prior application Serial No. _____.

9. ( )   A verified statement claiming small entity status under 37 CFR 1.9 and 1.27:

      ____   is enclosed herewith.

      ____   was filed in parent application Serial No. _____, and such status remains unchanged and is requested for this application.

10. ( )   A preliminary amendment is enclosed herewith.

11. ( )   An Information Disclosure Statement with Modified PTO Form 1449 and a copy of the cited references are enclosed herewith.

12. ( )   An Assignment of the invention to _TELEFONAKTIEBOLAGET LM ERICSSON (publ)_ with cover sheet and recordation fee is enclosed herewith for recordation by the Assignment Branch.

13. (XX)   The Commissioner is hereby authorized to charge payment, or to credit any overpayment, of the following fees associated with this filing or during the pendency of this application to Deposit Account No. 10-0447.
_X_   Any patent application filing fees under 37 CFR 1.16.
_X_   Any patent application processing fees under 37 CFR 1.17.
___   The issue fee under 37 CFR 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

14. ( )   Other (specify):_____

_____

_____.

15. (XX)   Confirmation Postcard.

Respectfully submitted,

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PACKET TRANSMISSION IN A UMTS NETWORK

Field of the Invention

5   The present invention relates to packet transmission in a Universal Mobile Telecommunications System (UMTS) network and more particularly to the scheduling of packets for transmission over the air interface of a UMTS network.

Background to the Invention

10

The European Telecommunications Standardisation Institute (ETSI) is currently in the process of standardising a new set of protocols for mobile telecommunications systems. The set of protocols is known collectively as the Universal Mobile Telecommunications System (UMTS). Figure 1 illustrates schematically a UMTS network 1 which

15   comprises a core network 2 and a UMTS Terrestrial Radio Access Network (UTRAN) 3. The UTRAN 3 comprises a number of Radio Network Controllers (RNCs) 4, each of which is coupled to a set of neighbouring Base Transceiver Stations (BTSs) 5. Each BTSs 5 is responsible for a given geographical cell and the controlling RNC 4 is responsible for routing user and signalling data between that BTS 5 and the core

20   network 2. All of the RNCs are coupled to one another. A general outline of the UTRAN 3 is given in Technical Specification TS 25.401 V2.0.0 (1999-09) of the 3rd Generation Partnership Project, ETSI.

User and signalling data may be carried between an RNC and a mobile terminal

25   (referred to in UTRAN as User Equipment (UE)) using Radio Access Bearers (RABs). Typically, a mobile terminal is allocated one or more Radio Access Bearers (RABs) each of which is capable of carrying a flow of user or signalling data. RABs are mapped onto respective logical channels. At the Media Access Control (MAC) layer, a set of logical channels is mapped in turn onto a transport channel, of which there are

30   two types: a "common" transport channel which is shared by different mobile terminals and a "dedicated" transport channel which is allocated to a single mobile terminal. One type of common channel is a Forward Access CHannel (FACH). A basic characteristic of a FACH is that it is possible to send one or more fixed size packets per transmission

time interval (10, 20, 40, or 80 ms). However, in any one given time interval all of the transmitted packets must be of the same length. Several transport channels (e.g. FACHs) are in turn mapped at the physical layer onto a Secondary Common Control Physical CHannel (S-CCPCH) for transmission over the air interface between a BTS
5 and a mobile terminal.

When a mobile terminal registers with an RNC, via a BTS, that RNC acts at least initially as both the serving and controlling RNC for the mobile terminal. The RNC both controls the air interface radio resources and terminates the layer 3 intelligence
10 (Radio Resource Control (RRC) protocol), routing data associated with the mobile terminal directly to and from the core network. Figure 2 illustrates the protocol model for the FACH transport channel when the serving and controlling RNCs are coincident and where Uu indicates the interface between UTRAN and the mobile terminal (UE), and Iub indicates the interface between the RNC and a NodeB (where NodeB is a
15 generalisation of a BTS). It will be appreciated that the MAC (MAC-c) entity in the RNC transfers MAC-c Packet Data Units (PDUs) to the peer MAC-c entity at the mobile terminal, using the services of the FACH Frame Protocol (FACH FP) entity between the RNC and the NodeB. The FACH FP entity adds header information to the MAC-c PDUs to form FACH FP PDUs which are transported to the NodeB over an
20 AAL2 (or other transport mechanism) connection. An interworking function at the NodeB interworks the FACH frame received by the FACH FP entity into the PHY entity.

Consider now the situation which arises when a mobile terminal leaves the area covered
25 by a RNC with which the terminal is registered, and enters the area covered by a second RNC. Under the UTRAN protocols, the RRC remains terminated at the first RNC whilst the terminal takes advantage of a cell and common transport channel of the second RNC. Thus, the first RNC remains as the serving RNC with a connection to the core network whilst the second RNC becomes the controlling RNC. The controlling
30 RNC is in control of the NodeB where the mobile terminal is located and in particular of the logical resources (transport channels) at that NodeB. In this scenario the controlling RNC is referred to as a "drift" RNC (the controlling RNC will also be acting as a serving RNC for mobile terminals registered with that RNC). The protocol model

for the FACH transport channel when the serving and controlling RNCs are separate is illustrated in Figure 3. It will be noted that a new interface Iur is exposed between the serving and the controlling RNCs. An Iur FACH FP is used to interwork the Common MAC (MAC-c) at the controlling RNC with the Dedicated MAC (MAC-d) at the serving RNC.

In both of the scenarios illustrated in Figures 2 and 3, an important task of the MAC-c entity is the scheduling of packets (MAC PDUs) for transmission over the air interface. If it were the case that all packets received by the MAC-c entity were of equal priority (and of the same size), then scheduling would be a simple matter of queuing the received packets and sending them on a first come first served basis. However, UMTS defines a framework in which different Quality of Services (QoSs) may be assigned to different RABs. Packets corresponding to a RAB which has been allocated a high QoS should be transmitted over the air interface as a high priority whilst packets corresponding to a RAB which has been allocated a low QoS should be transmitted over the air interface as a lower priority. Priorities are determined at the MAC entity (MAC-c or MAC-d) on the basis of RAB parameters.

UMTS deals with the question of priority by providing at the controlling RNC a set of queues for each FACH. The queues are associated with respective priority levels. An algorithm is defined for selecting packets from the queues in such a way that packets in the higher priority queues are (on average) dealt with more quickly than packets in the lower priority queues. The nature of this algorithm is complicated by the fact that the FACHs which are sent on the same physical channel are not independent of one another. More particularly, a set of Transport Format Combinations (TFCs) is defined for each S-CCPCH, where each TFC comprises a transmission time interval, a packet size, and a total transmission size (indicating the number of packets in the transmission) for each FACH. The algorithm must select for the FACHs a TFC which matches one of those present in the TFC set.

Statement of the Invention

A possible problem arises where the controlling RNC is a drift RNC. This is because the MAC-d entity exists at the serving RNC, and it is the MAC-d entity which allocates priorities to packets, based upon the packet scheduling algorithm used by that RNC (when acting as a controlling RNC). The allocated priorities and packet sizes may not

5   however conform with the packet scheduling algorithm used by the drift RNC. Packets received at the drift RNC from the serving RNC may not therefore be dealt with with an appropriate priority.

According to a first aspect of the present invention there is provided a method of

10 scheduling packets for transmission over the air interface of a UMTS Terrestrial Radio Access Network (UTRAN) in the case where a pair of Radio Network Controllers (RNCs) are acting as separate serving and controlling RNCs for a mobile terminal, the method comprising:

sending from the controlling RNC to the serving RNC, allocated scheduling

15 priorities together with packet sizes accepted for transmission with those priorities on transport channels by the controlling RNC; and

subsequently sending from the serving RNC to the controlling RNC packets of sizes accepted by the serving RNC together with respective allocated priorities.

20 Embodiments of the present invention ensure that a serving RNC allocates a packet size to a given priority which is acceptable to the controlling RNC, avoiding a mis-match between priority and packet size at the controlling RNC.

Preferably, the information sent from the controlling RNC to the serving RNC

25 comprises a set of allocated priorities, each having one or more associated package sizes, for each of a plurality of logical channel types to be mapped onto a transport channel at the controlling RNC. More preferably, said information comprises such a set for each logical channel type to be mapped onto a transport channel at the controlling RNC.

30

It will be appreciated that the packet sizes which may be allocated to priorities may change, depending for example upon the load in a cell serving the mobile terminal or in the event that the mobile terminal moves into another cell controlled by the same

controlling RNC. Preferably therefore, a new list of packet sizes and priorities may be sent from the controlling RNC to the serving RNC under appropriate circumstances.

Preferably, the list of priorities and packet sizes is received at the serving RNC by the
5   RRC entity. More preferably, the list is sent in a RNSAP message.

Preferably, a packet received at the controlling RNC is placed in a queue for transmission on a Forward Access CHannel (FACH), the queue corresponding to the priority level attached to the packet and to the size of the packet. The FACH is mapped
10 onto a S-CCPCH at a Base Transceiver Station (BTS) or other corresponding node of the UTRAN. More preferably, the packets for transmission on the FACH are associated with either a Dedicated Control CHannel (DCCH) or to a Dedicated traffic CHannel (DTCH).

15 Preferably, each FACH is arranged to carry only one size of packets. This need not be the case however, and it may be that the packet size which can be carried by a given FACH varies from one transmission time interval to another.

A given priority may be allocated one or more packet sizes, defined in the list sent to
20 the serving RNC.

According to a second aspect of the present invention there is provided a UMTS Terrestrial Radio Access Network (UTRAN) comprising a plurality of interconnected Radio Network Controllers (RNCs), wherein, when a mobile terminal has separate
25 serving and controlling RNCs, the controlling RNC is arranged to send to the serving RNC, packet sizes accepted for transmission by the controlling RNC together with allocated relative priorities which may be attached to those accepted packets sizes, and the serving RNC is arranged to send to the controlling RNC data packets having sizes accepted by the serving RNC, together with respective allocated priorities.

30

Brief Description of the Drawings

Figure 1 illustrates schematically a UMTS network comprising a core network and a UTRAN;

5 Figure 2 illustrates a protocol model for a FACH transport channel when serving and controlling RNCs of the UTRAN of Figure 1 are coincident;

Figure 3 illustrates a protocol model for a FACH transport channel when serving and controlling RNCs of the UTRAN of Figure 1 are separate;

10 Figure 4 is a flow diagram illustrating a method of scheduling packets for transmission at a controlling RNC of the UTRAN of Figure 1.

Detailed Description of a Preferred Embodiment

15 The general structure of a UMTS network has been described above with reference to the schematic drawing of Figure 1. Protocol models for the FACH transport channel have also been described with reference to Figures 2 and 3 for the cases where the serving RNC and controlling RNC are both coincident and separate.

20 Considering the scenario illustrated in Figure 3, where a mobile terminal communicates with the core network of a UMTS system via separate serving and controlling (or drift) RNCs within the UTRAN, signalling and user data packets destined for the mobile terminal are received at the MAC-d entity of the serving RNC from the core network and are "mapped" onto logical channels, namely a Dedicated Control CHannel (DCCH)
25 and a Dedicated traffic CHannel (DTCH). The MAC-d entity constructs MAC Service Data Units (SDUs) comprising a payload section containing logical channel data and a MAC header containing amongst other things a logical channel identifier.

The MAC-d entity passes the MAC SDUs to the FACH Frame Protocol (FP) entity.
30 This entity adds a further FACH FP header to each MAC SDU, the FACH FP header including a priority level which has been allocated to the MAC SDU by a Radio Resource Control (RRC) entity. The RRC is notified of available priority levels, together with an identification of one or more accepted packet sizes for each priority

7

level, following the entry of a mobile terminal into the coverage area of the drift RNC. At that time, the controlling RNC issues a resource request to the drift RNC. More particularly, this request is a Common Transport Channel Request having the following form:

5

Information element	Reference	Type
Message type		M
Transaction ID		M
D-RNTI		M
Cell Id		M
Transport Bearer Request Indicator		M

where "M" indicates a mandatory field.

10   The drift RNC responds to receipt of the resource request by returning a response message (RNSAP), referred to as a Common Transport Channel Response, having the following form:

Information element	Reference	Type
Message type		M
Transaction ID		M
Common Transport Channel Information		
Common Transport Channel Priority Indicator		M
Common Transport Channel Initial Window size		M
Common Transport Channel Data Frame Size		
Data Frame Size		M
Transport Layer Address		O
Binding Identity		O
DL Channelisation Code		O

where again "M" indicates a mandatory field and "O" indicates an optional field. The

15   RNSAP message contains a list of priorities accepted by the drift RNC, together with an identification of one or more accepted packet sizes for each priority. Such a list may be sent for each logical channel type although this need not be the case. The list of priorities is sent to each MAC-d entity connected to the MAC-c entity in the drift RNC. For example, the list may define that for SDUs having a priority 1, a MAC-d entity may

20   use packet sizes of 80 or 320 bits. Where a priority/packet size list is provided for each logical channel type, the RNSAP message used to carry the list contains a logical channel type identifier directly after the Common Transport Channel information.

The priority/packet size list is typically sent from the drift RNC to the serving RNC when a mobile terminal first enters the coverage area of a new RNC whilst being previously registered with another RNC. An updated list may be exchanged between

5   the drift RNC and the serving RNC when the terminal moves between cells of the new RNC to reflect the priorities available at the new BTS. It will also be appreciated that an updated list may be sent even when a mobile terminal remains within a given cell, due to changing circumstances such as changes in the levels of traffic in the cell or a reconfiguration of the radio network resources.

10

The RRC examines the received RNSAP message and carries out any necessary reconfiguration of the MAC-d entity. A reconfiguration of the Radio Link Control (RLC) entity (which resides above the MAC-d layer in the serving RNC and is responsible for the segmentation of data) additionally takes place.

15

The FACH FP packets are sent to a peer FACH FP entity at the drift RNC over an AAL2 connection. The peer entity decapsulates the MAC-d SDU and identifies the priority contained in the FRAME FP header. The SDU and priority are passed to the MAC-c entity at the controlling RNC. The MAC-c layer is responsible for scheduling

20   SDUs for transmission on the FACHs. More particularly, each SDU is placed in a queue corresponding to its priority and size (if there are 16 priority levels there will be 16 queue sets for each FACH, with the number of queues in each set depending upon the number of packet sizes accepted for the associated priority). As described above, SDUs are selected from the queues for a given FACH in accordance with some

25   predefined algorithm (so as to satisfy the Transport Format Combination requirements of the physical channel).

It will be appreciated by those of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the present

30   invention. For example, the above embodiment requires the sending of a priority/packet size list in an RNSAP message. In an alternative embodiment, a RNC may issue a "global" list covering all mobile terminals using that RNC as a drift RNC.

Claims

1.   A method of scheduling packets for transmission over the air interface of a UMTS Terrestrial Radio Access Network (UTRAN) in the case where a pair of Radio
5   Network Controllers (RNCs) are acting as separate serving and controlling RNCs for a mobile terminal, the method comprising:

    sending from the controlling RNC to the serving RNC, allocated scheduling priorities together with packet sizes accepted for transmission with those priorities by the controlling RNC; and

10   subsequently sending from the serving RNC to the controlling RNC packets of sizes accepted by the serving RNC together with respective allocated priorities.

2.   A method according to claim 1, wherein the information sent from the controlling RNC to the serving RNC comprises a set of allocated priorities, each having
15   one or more associated package sizes, for each of a plurality of logical channel types to be mapped onto a transport channel at the controlling RNC.

3.   A method according to claim 2, wherein said information comprises such a set for each logical channel type to be mapped onto a transport channel at the controlling
20   RNC.

4.   A method according to claim 1, wherein a new list of packet sizes and priorities is sent from the controlling RNC to the serving RNC to replace an old list, following a change in circumstances at the controlling RNC.

25

5.   A method according to claim 1, wherein the list of priorities and packet sizes is received at the serving RNC by a MAC-d entity.

6.   A method according to claim 5, wherein the list is sent to the serving RNC in a
30   RNSAP message.

7.   A method according to claim 1, wherein a packet received at the controlling RNC is placed in a queue for transmission on a Forward Access CHannel (FACH), the

queue corresponding to the priority level attached to the packet and to the size of the packet.

8.   A UMTS Terrestrial Radio Access Network (UTRAN) comprising a plurality of
5   interconnected Radio Network Controllers (RNCs), wherein, when a mobile terminal has separate serving and controlling RNCs, the controlling RNC is arranged to send to the serving RNC, packet sizes accepted for transmission by the controlling RNC together with allocated relative priorities which may be attached to those accepted packets sizes, and the serving RNC is arranged to send to the controlling RNC data
10   packets having sizes accepted by the serving RNC, together with respective allocated priorities.

15

11

ABSTRACT

PACKET TRANSMISSION IN A UMTS NETWORK

A method of scheduling packets for transmission over the air interface of a UMTS Terrestrial Radio Access Network (UTRAN) in the case where a pair of Radio Network Controllers (RNCs) are acting as separate serving and controlling (drift) RNCs for a mobile terminal. The method comprises sending from the controlling RNC to the serving RNC, allocated scheduling priorities together with packet sizes accepted for transmission with those priorities by the controlling RNC. Subsequently the serving RNC send to the controlling RNC, packets of sizes accepted by the serving RNC together with respective allocated priorities.
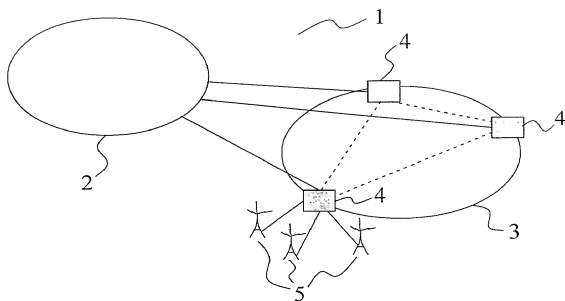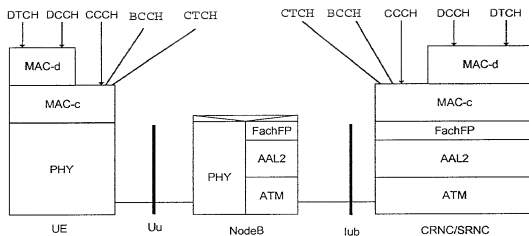
Figure 3

Figure 1

Figure 2

Figure 3

Send Common Transport Channel Request from serving RNC to drift RNC

↓

Return Common Transport Channel response from drift RNC to serving RNC, the message including a list of priorities and respective accepted packet sizes

↓

Provide list to RRC entity at the serving RNC

↓

Allocate priorities to user and signalling packets at serving RNC and include priority in FACH FP header

↓

Send PDUs from serving RNC to drift RNC

↓

Add PDUs to MAC-c queues according to packet priorities and sizes
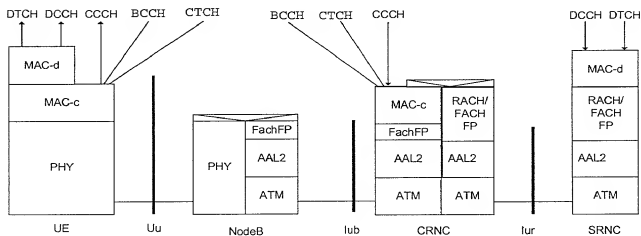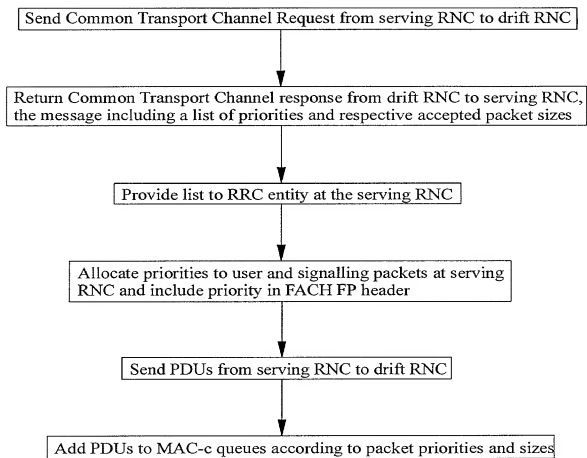
Figure 4

**RULES 63 AND 67 (37 C.F.R. 1.63 and 1.67)
DECLARATION AND POWER OF ATTORNEY**

FOR UTILITY/DESIGN/CIP/PCT NATIONAL APPLICATIONS

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **PACKET TRANSMISSION IN A UMTS NETWORK**, the specification of which: (mark only one)

X	(a)	is attached hereto.
—	(b)	was filed on _____ as Application Serial No. _____ and was amended on _____ (if applicable)
—	(c)	was filed as PCT International Application No. PCT/_____ on ____ and was amended on _____ (if applicable).
—	(d)	was filed on ____ as Application Serial No. ___ and was issued a Notice of Allowance on ____.
—	(e)	was filed on ___ and bearing attorney docket number ____

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above or as allowed as indicated above.

I acknowledge the duty to disclose all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56. If this is a continuation-in-part (CIP) application, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability of the application as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which my priority is claimed or, (2) if no priority is claimed, before the filing date of this application:

PRIOR FOREIGN PATENTS

Number	Country	Month/Day/Year Filed	Date first laid-open or Published	Date patented or Granted	Priority Claimed Yes	No
GB9924764.5	Great Britain	19 October 1999			X	

I hereby claim the benefit under 35 U.S.C. § 120/365 of any United States application(s) listed below and PCT international applications listed above or below:

PRIOR U.S. OR PCT APPLICATIONS

Application No. (series code/serial no.)   Month/Day/Year Filed   Status(pending, abandoned, patented)

None

I hereby appoint:

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all of the firm of **JENKENS & GILCHRIST, a Professional Corporation**, 1445 Ross Avenue, Suite 3200, Dallas, Texas 75202-2799, as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application, provisionals thereof, continuations, continuations-in-part, divisionals, appeals, reissues, substitutions, and extensions thereof and to transact all business in the United States Patent and Trademark Office connected therewith, to appoint any individuals under an associate power of attorney and to file and prosecute any international patent application filed thereon before any international authorities, and I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/organization who/which first sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct them in writing to the contrary.

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